NWFSC Watershed Program Open House
Museum of History and Industry
2700 24th East, Seattle, Washington 98112
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ABSTRACTS

9:00 – 9:20 **Beechie, T., C. Greene, P. Kiffney, M. Pollock, B. Reichert and C. Rice. Known knowns, known unknowns, and unknown unknowns: an overview of Ecosystem Processes research.**

Abstract – The Ecosystem Processes Team focuses its research on understanding how humans have impacted ecosystems that support salmon, and how we might help restore and manage those ecosystems. In general, we know that landscape processes form aquatic habitats and that aquatic habitat conditions regulate fish populations. Some mechanistic linkages between processes, habitats, and fish are understood well enough that we can predict biological outcomes of certain management actions. However, many of the linkages are poorly understood, necessitating basic research to take the first steps towards developing predictive models. Hence, our research includes: (1) use of current knowledge and research to develop predictive models for habitat management and salmon recovery (the application of known knowns to management problems), (2) incorporating uncertainties into predictive models to illustrate the range and likelihood of potential biological responses (quantifying known unknowns to inform managers), and (3) new research to understand processes that we cannot currently model (addressing the unknown unknowns). We present two examples of each type to illustrate how our ecosystem process research informs salmon recovery planning and habitat restoration activities, both for population- or ESU-level assessments and for process-based analyses at the reach scale. In the first pair of examples (applying the known knowns), we use our knowledge of how land uses translate to habitat changes to evaluate the potential for habitat actions to improve population status across multiple ESUs, and briefly illustrate how we can inform the reach-level riparian management through modeling of known processes and functions. For the second set of examples (the known unknowns), we incorporate variation in characteristics of Chinook spawning sites and densities to increase confidence in assessments of spawning habitat limitations on salmon populations, and use known variation in sediment supply and aggradation rates to illustrate uncertainty in predicting recovery rates for incised stream channels. Finally, for unknown unknowns, we show that new research on juvenile salmon distributions in Puget Sound sets new directions for nearshore research, and that research on floodplain dynamics advances the development of tools for predicting the response of floodplain ecosystems to restoration efforts.

2:50 – 3:05 **Bennett, T., R. Wissmar (University of Washington), P. Roni, R. Bilby (Weyerhaeuser company), T. Quinn (University of Washington), E. Prentice (FE Division, NWFSC), S. Downing (FE Division, NWFSC), B. Jonasson (FE Division, NWFSC) and M. McHenry (Lower Elwha Klallam Tribe). Movement and survival of juvenile salmonids in simple and complex stream reaches in the East Twin River, Washington.**

Abstract – We assessed the individual movement and habitat-specific survival of three salmonid species in two simple and two complex reaches in a Western Washington stream. Simple and complex reaches were stratified by wood loading levels and pool spacing for comparison of habitat quantity and quality. Approximately 1,200 and 3,300 juvenile coho salmon (*Oncorhynchus kisutch*), rainbow trout/steelhead (*O. mykiss*), and cutthroat trout (*O. clarki*) were collected in each reach by habitat type, PIT tagged, paint marked, and returned to the original habitat in the fall of 2003 and 2004 respectively. Using snorkel surveys with a mobile PIT tag detector, permanent instream PIT tag antennae, and a smolt trap in the spring, movement and habitat specific over-winter survival were estimated. In 2003 and 2004, high water and a smaller number of tagged fish inhibited tracking and resulted in fewer recaptures at the smolt trap than expected (3.4%). In fall 2004, 3,300 individuals were tagged and instream

PIT tag antennae were installed. Preliminary results indicate that there is a large (nearly 13%) outmigration of tagged fish in the fall months, which may explain poor tag returns to the smolt trap in spring 2004. Monitoring will continue into the summer of 2005.

3:05 – 3:20 **Coe, H., P. Kiffney, G. Pess, K. Kloehn, S. Morley and M. McHenry (Lower Elwha Klallam Tribe). Monitoring invertebrate and periphyton responses to wood placement in the Elwha and N. Fork Stillaguamish Rivers.**

Abstract – Woody debris is essential for maintaining ecological structure and function in the Pacific Coastal Ecoregion. Over the past century, however, human activities such as logging, splash damming and channel alteration for navigation have altered the input, transport, distribution and abundance of woody debris in aquatic habitats. To mitigate these changes, woody debris placement has become a widely used instream enhancement method. Many wood enhancement projects have focused on evaluating physical habitat responses of small streams (< 12 m bankfull width) using techniques appropriate for small streams, yet little emphasis has been placed on biological responses or responses in large rivers (> 30 m bankfull width). The goal of this study was to evaluate biological responses to log jam placement in two large Pacific coastal river systems (bankfull width > 30 m) with reduced wood inputs and abundance. In 2003 and 2004, we sampled invertebrate and periphyton biomass at the habitat-unit scale in treatment (with wood) and control (without wood) reaches on the Elwha and North Fork Stillaguamish Rivers. As existing methods for sampling wood are not designed for collecting periphyton in large rivers where log jams form extensive pool habitat, a new method was developed for sampling periphyton on wood. We found that invertebrate and periphyton biomass was higher in treatment habitats suggesting that wood can support high levels of productivity in large river systems. Ultimately our results will be incorporated into a larger, ongoing effort to monitor the biological and physical effects of log jam placement in Pacific coastal rivers.

12:35 – 12:50 **Feist, B.E., C.J. Harvey (FRAM Division, NWFSC), J.L. Ruesink (University of Washington) and A.C. Trimble (University of Washington). "Inconspicuous" impacts of non-indigenous species in a Pacific Northwest estuary.**

Abstract – Invasive non-indigenous species (NIS) are widely touted in the scientific and popular literature as a major threat to the environment. Some of the specific threats include extirpation of endemic species with concomitant decline in species richness, as well as loss of ecosystem services and productivity. In my presentation, I will summarize the work we have done in Willapa Bay, which has been altered from the introduction of three dozen marine NIS over the past century. While most of these NIS are inconspicuous, a handful of them (two tracheophyte species: eastern smooth cordgrass (*Spartina alterniflora*) and Japanese eelgrass (*Zostera japonica*); and two bivalve species: Pacific oysters (*Crassostrea gigas*), and Manila clams (*Venerupis philippinarum*)) are dominant features of the estuarine ecosystem. In order to better understand the impacts of these four NIS, we used a systems approach, whereby we characterized changes in primary productivity, as well as nutrient flux. We found that the two NIS tracheophytes have increased primary productivity by 50%, and the two bivalve species have increased secondary production by 250% over peak historic values. Our data suggest that organic matter derived from *Spartina alterniflora*, is a major component of total estuarine primary productivity, and it is apparently being consumed by Pacific oysters. It is likely exported offshore and even into nearby Grays Harbor. Given that there have not been any documented extirpations of endemic species, we conclude that species richness in Willapa Bay has increased as a result of NIS introductions. While total ecosystem productivity is clearly greater than it was historically, the sources of this productivity have changed.

1:05 – 1:20 **Fullerton, A.H., T.J. Beechie, S.E. Baker, J.E. Hall and K.A. Barnas (CB Division, NWFSC). Landscape analyses of riparian condition in the Columbia River Basin: implications for riparian restoration.**

Abstract – Riparian areas comprise a small fraction of the landscape yet provide multiple key in-stream functions. Therefore, estimating riparian condition is essential for predicting stream habitat quality and for planning restoration projects. To determine roughly how much riparian vegetation along anadromous fish-bearing streams in

the Interior Columbia River Basin may be degraded due to current land use practices, we conducted analyses at multiple resolutions. Our technique provides an estimate of coarse-scale relationships between land-use and riparian condition as well as a comparison of riparian condition across watersheds. We identified riparian buffers in several land use/cover classes throughout the study area using remotely sensed data. We then interpreted aerial photographs at random locations within each of these classes to quantify riparian modifications at the stream reach scale. Riparian buffers in agricultural and urban areas were significantly narrower than those in forested or shrub/grass areas: median buffers were around 30m and 70m in modified and natural land use categories, respectively. Areas with the highest proportion of modified riparian buffers occurred predominantly in floodplains, in semi-arid ecoregions, and in areas predicted to be high potential fish habitat. We investigated spatial overlap of riparian condition predicted by our analyses with active riparian restoration projects to assess the utility of the approach we used to estimate riparian condition over large spatial scales for prioritizing type and location of future projects. Successful plans for restoring high quality salmon habitat will be highly watershed-specific and will necessarily include restoration of habitat-forming processes required to provide natural riparian, sediment delivery, and hydrologic functions.

10:15 – 10:30 **Greene, C. and E. Beamer (Skagit River System Cooperative). Estuary-nearshore connections and their importance for estuary restoration.**

Abstract – Many listed salmonid species in the Pacific Northwest rely on estuary habitat for a significant period during rearing. Because most estuaries of large river systems have undergone greater than 80% habitat loss, habitat restoration efforts have often targeted tidal deltas of these rivers. These efforts may provide great benefits to populations, but determining the extent of these benefits may be challenged by the complexity of fish-habitat relationships. In this talk, I review what we know about patterns of rearing in the Skagit River tidal delta and nearshore. The evidence supports the existence of habitat limitations in the Skagit River tidal delta. During years of large outmigrations, large numbers of juvenile Chinook salmon enter Skagit Bay at a relatively small body size. This pattern appears most pronounced when the local density exceeds a threshold. Density limitations therefore appear to mediate migration out of the tidal delta. The consequence of density-dependent migration is increased numbers of small salmon entering Skagit Bay. Our current evidence indicates that this nearshore environment is a site of high mortality. These findings support our contention that the main consequence of estuary restoration may be higher survival in the nearshore, and that efforts to monitor the effects of estuary restoration should include both estuary and nearshore components.

9:35 – 9:50 **Kiffney, P.M., C. Greene, T. Good (CB Division, NWFSC), T. Beechie and J. Hall. Describing patterns and processes of river network connections: implications for conservation and biodiversity.**

Abstract – Theoretical and empirical studies provide insights into processes explaining patterns in biodiversity. One theory suggests that more complex environments support a greater number of species. A second suggests that more productive habitats support a greater number of species because there is more energy available allowing for larger populations. These two processes likely interact in nature creating a mosaic in patterns of habitat complexity and productivity, with both contributing to patterns in biodiversity. In river landscapes, connections among habitats are important nodes of habitat complexity and productivity. For instance, small, dark tributary streams intersect sunlit mainstem habitats subsidizing these food webs with inorganic and organic materials. Connections between mainstem and floodplain habitat is critical for maintaining the diversity of off-channel habitats. Maintaining and restoring these network connections may be critical to supporting biodiversity and productivity of a variety of terrestrial and aquatic organisms. We present data that shows connections between tributary and mainstem and mainstem and off-channel habitat are locations within river networks with high biological diversity and productivity. We suggest that maintaining the integrity of riverine connections is essential to successful restoration and conservation of Pacific salmon.

3:35 – 3:50 **Liermann, M. and P. Roni. Assessing multi-year, multi-site sampling designs for estimating average effect size of reach and basin scale habitat restoration.**

Abstract – Restoration monitoring has typically focused on a single site for multiple years (BACI), or multiple sites for a single year (extensive post treatment), each having statistical and economic trade-offs. We compare restoration monitoring designs with multiple years and sites in order to quantify the trade-off between expending effort on additional years versus additional sites. We use coho parr and smolt data from several monitoring projects, along with estimates of cost, to determine which designs are likely to provide the most precise and accurate estimates of average restoration effect size for a given expenditure. A simulation approach allows us to determine how robust the results are to plausible ranges of temporal auto-correlation and site-to-site variability in effect size.

10:45 – 11:00 **Macneale, K.H., B.L. Sanderson and P.M. Kiffney. Impacts of non-native brook trout on endangered juvenile Chinook salmon in Idaho streams.**

Abstract – In streams throughout the Salmon River basin in Idaho, the presence of non-native brook trout (*Salvelinus fontinalis*) is correlated with reduced survival of juvenile Chinook salmon (*Oncorhynchus tshawytscha*). To identify potential mechanisms, we analyzed diet overlap and made in-stream observations of individual Chinook and brook trout, quantifying their distribution, habitat use and overlap, and interactions with neighboring fish. In Summit Creek, where native trout are rare and the abundances of brook trout and Chinook are similar by the end of the summer, we made observations while snorkeling and used multiple regression analyses to identify variables explaining encounter rates, outcomes of encounters, and feeding rates. Encounters among fish were frequent, with Chinook displaced most often by larger brook trout. The size of neighboring fish was the most important variable in explaining the rate and outcome of encounters. Brook trout were on average 1.5x larger than Chinook in late summer, indicting their potential impact on Chinook feeding behavior is large. Efforts to recover threatened Chinook will likely be most effective when impacts of non-native species are understood and considered.

2:35 – 2:50 **Morley, S., H. Coe, J. Duda (USGS Western Fisheries Research Center), K. Kloehn, G. Pess, M. McHenry (Lower Elwha Klallam Tribe), S. Sampson (Lower Elwha Klallam Tribe), M. Liermann, T. Beechie and P. Kiffney. Pre-dam removal monitoring in the Elwha River Basin: establishing baseline conditions for primary and secondary productivity.**

Abstract – In order to effectively evaluate the potential effects of dam removal on primary and secondary productivity in the Elwha River Basin, a coordinated data-collection effort is needed for establishing pre-dam removal conditions. Building on earlier monitoring work conducted by the Lower Elwha Tribe and the USGS in the mid-90's, we began collecting baseline data in the summer of 2004. In order to sample mainstem, tributary, and side channel habitats below, between, and above the dams, data collection was coordinated amongst NOAA, the USGS, and the Lower Elwha Klallam Tribe. The focus of this first year of data collection was on standardizing data collection protocols, collecting a representative number of samples from varied habitats, and on establishing long-term monitoring locations. Along with physical habitat characterization, at each of our monitoring sites we collected benthic invertebrates, periphyton, and water chemistry samples. Based on this collaborative research effort, we will determine adequate sample size, appropriate spatial distribution of samples sites (lateral and longitudinal), and refine sampling protocols as necessary for ongoing dam removal monitoring.

3:50 – 4:05 **Pess, G. and T. Quinn (University of Washington). Patterns and processes of salmon colonization and straying: a literature review.**

Abstract – Reproductive migration and homing behavior is common in Atlantic (Salmo salar) and Pacific salmon (Oncorhynchus spp.). Their philopatric nature is well documented; however, the converse behavior of straying has allowed salmonid populations over their evolutionary history to colonize new habitats. Salmon can disperse and colonize new habitats, or recolonize formerly disconnected habitats quickly, establishing self-sustaining populations. Natal sites are not static because habitat is a shifting mosaic that changes with anthropogenic

alterations and other large-scale disturbances that force dispersal and colonization of new habitats. For example, in deglaciated streams of southeast Alaska multiple salmonid populations have established themselves within recent decades of glacial retreat. Why do salmonids stray and what causes the strays to succeed and become colonists? This literature review investigates how the establishment of self-sustaining salmonid populations in newly opened or reopened habitats is related to the compatibility between specific life history adaptations and geomorphic and ecological conditions that determine stream-habitat characteristics. In this manner, salmon straying can be thought of as non-random movement to a particular type of place rather than just random straying. The hypothesis helps us to focus on four specific factors that can influence successful recolonization including: 1) distance from a source population, 2) different habitat preferences among species, 3) local adaptations within species, and 4) competition amongst and within species. The review advances our understanding of how salmon colonization occurs over time and in multiple settings. This will allow for model development to answer more applied questions of what may transpire once barriers are removed for fish passage, and how different fish management strategies may effect salmon recolonization.

9:20 – 9:35 **Pollock, M. Riparian-aquatic feedback loops in the interior Columbia River basin.**

Abstract – Incised streams and the concomitant loss of extensive riparian forests and meadows are now a common feature of watersheds in much of the semi-arid regions of the American west, resulting in the loss of important riparian-aquatic feedback loops in these systems. We examined the feasibility of restoring these riparian-aquatic feedback loops in incised (downcut) streams throughout the semi-arid regions of the interior Columbia River basin. Initial results suggest that under proper land use management, it is possible for streams to aggrade (fill back up) such that they become hydrologically reconnected to their former floodplains within relatively short time frames, thus greatly expanding the extent and quality of riparian vegetation and improving off-channel stream habitat. Theoretical and empirical evidence suggests that over decadal time scales, changes to land management that improve riparian conditions result in several positive feedback loops that benefit stream organisms such as fishes. Increases in woody riparian vegetation such as willow and cottonwood provide food and dam-building materials for beaver (*Castor canadensis*), which are then able to colonize streams and build dams, which then trap sediment and aggrade streams. This in turn helps to create wide, shallow floodplain aquifers that can be accessed by the roots of riparian floodplain vegetation, leading to a rapid expansion of riparian habitat in these systems (and providing more food for beaver), once the water table rises close to the former floodplain surface. We theorize further that the raised water tables will provide a subsurface source of water to downstream reaches and enhance exchange between surface and hyphoreic water, thus improving aquatic habitat by lowering the average temperature of surface waters. The increase in riparian vegetation should also lead to increased allochthonous inputs of organic material, which provide a food source for the detrital food chain, and ultimately, for “higher” organisms such as fishes which prey upon detritivores.

10:30 – 10:45 **Rice, C., C. Greene and K. Kloehn. Evaluating the biological condition of Puget Sound.**

Abstract – While significant portions of Puget Sound biota continue to decline, and pressure placed on the ecosystem by society continues to increase, major gaps exist in our understanding of natural ecosystem structure and function in Puget Sound, and the biological consequences of human activity. By drawing from several distinct research projects we illustrate the importance of considering landscape, ecosystem, and human influence contexts in improving biological assessment and monitoring in Puget Sound. First, anthropogenic shoreline modification (a disturbance that affects at least one third of the Puget Sound shoreline) is associated with local changes in beach microclimate and increased embryo mortality in summer spawning surf smelt (*Hypomesus pretiosus*). Second, existing data from aerial surveys of marine birds and waterfowl over thirteen years are used to relate changes in bird assemblage composition to adjacent land cover and shoreline structure throughout Puget Sound. Third, data from surface trawl sampling over three years in the Skagit River estuary and one year throughout much of Puget Sound show local and landscape – scale contrasts in estuarine habitat use by hatchery versus wild juvenile Chinook salmon (*Oncorhynchus tshawytscha*), and differences in macrofaunal (fish and gelatinous zooplankton) assemblage composition. Results from these studies not only help document anthropogenic alterations of the Puget Sound ecosystem, but also suggest methods and hypotheses for future research, assessment, and monitoring.

3:20 – 3:35 **Roni, P., K. Hanson, T. Beechie, G. Pess, M. Pollock and D.M. Bartley (FAO of the United Nations). Global review of effectiveness of habitat rehabilitation techniques and guidance for restoration of freshwater ecosystems.**

Abstract – The degradation of inland aquatic habitats through decades of human activities has lead to massive efforts to rehabilitate freshwater habitats for fisheries and aquatic resources throughout the world. We reviewed published evaluations of freshwater habitat rehabilitation projects from throughout the world including studies on roads improvements and sediment reduction, riparian and floodplain rehabilitation, placement of habitat structures in lakes and streams, addition of nutrients to increase aquatic production, and other less common techniques. In particular, we summarize what is known about the effects of various techniques for restoring natural processes, improving habitat, and increasing fish and biotic production. Recommendations on limitations of techniques, which techniques are effective, as well as information on planning, prioritizing and monitoring rehabilitation projects are also provided.

Despite locating more than 330 studies on effectiveness as well as hundreds of other papers on rehabilitation, it was difficult to draw firm conclusions about many specific techniques because of the limited information provided on physical habitat, biota, and costs, as well as the short duration and scope of most published evaluations. However, techniques such as reconnection of isolated habitats, rehabilitation of floodplains, and placement of instream structures have proven effective for improving habitat and increasing local fish abundance under many circumstances. Techniques that restore processes, such as riparian rehabilitation, sediment reduction methods (road improvements), dam removal, and restoration of floods, also show promise, but may take years or decades before a change in fish or other biota is evident. Other techniques such as bank protection, beaver removal, and bank debrushing can produce positive effects for some species but more often produce negative impacts on biota or disrupt natural processes. Similar to less comprehensive reviews of rehabilitation, our review demonstrates three key areas lacking in most rehabilitation projects: 1) adequate assessment of historic conditions, impaired ecosystem processes, and factors limiting biotic production; 2) understanding upstream or watershed-scale factors that may influence effectiveness of reach or localized rehabilitation; and 3) well designed and funded monitoring and evaluation. Finally, our review suggests that many habitat rehabilitation techniques show promise, but most have not received adequate planning, monitoring, or cost-benefit analysis.

12:50 – 1:05 **Sanderson, B.L., K. Barnas (CB Division, NWFSC) and M. Rub (CB Division, NWFSC). Non-indigenous species of the Pacific Northwest: an overlooked risk?**

Abstract – Non-indigenous species are recognized as one of the major threats to global diversity and have been cited as a cause of decline in 42% of species listed under the US Endangered Species Act. During their life cycle, salmonids traverse large geographic areas spanning freshwater, estuary and ocean habitats where they encounter numerous non-native species. To date, the cumulative impact of non-indigenous species on salmonids has not been described or quantified. We examine the extent to which introduced species are a potentially important risk to threatened and endangered salmon, ultimately by contributing to higher levels of life-cycle mortality. We identify and categorize all documented introduced species in the Pacific Northwest, including fish, invertebrates, birds, plants, amphibians and others. Where data exist, we quantify the impact of non-indigenous species on populations of threatened and endangered salmonids. For example, birds and fish predators are reported to consume 0-40% of juvenile salmon in some habitats. These data indicate that the impact of non-indigenous species on salmon is equal to or greater than commonly addressed impacts (habitat, harvest, hatcheries and hydro-system) and suggest that managing non-indigenous species impacts may be imperative for the recovery of these fish.

1:20 – 1:35 **Steel, A., I. Lange (University of Washington) and B. Feist. Wavelets and water temperature: how fancy stats can help assess the effects of dams, the variability of natural systems, and the impacts of land-use alternatives.**

Abstract – Maintaining the natural temporal complexity of water temperature regimes is one of the keys to maintaining diverse biological communities. Insect communities, food webs, and fish respond to the magnitude

and duration of water temperature fluctuations. Disruption of natural patterns has the potential to alter physiological process, behavioral adaptations, and community structure and dynamics. We analyzed long time series of water temperature data from the Willamette River basin, Oregon, to assess the impact of large multi-purpose dams on water temperature variability at temporal scales ranging from 1 - 32 d, short temporal scales that are commonly ignored. In addition to the well-documented effects of dams on seasonal patterns in water temperature or on water temperature maximums, our results demonstrate that dams have significantly muted the small temporal scale variance in water temperature patterns to which many organisms may have been adapted. We provide evidence that anthropogenic impacts to river systems can include reductions in temporal variability, an often-overlooked regulator of riverine communities. We also introduce research to investigate the impacts of large-scale land-use patterns on these small-scale variations in water temperature and also flow. In addition, we present data on multiple channels within a floodplain to examine natural temporal and spatial variation in water temperature regimes. Conserving or restoring natural temperature patterns in rivers will require attention to these small-scale complexities.